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Report 1:

FIRE RISKS IN SOUTHERN INTERFACE LANDSCAPES

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September 2002

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Preface

This report, entitled “Report 1: Fire Risks in Southern Interface Landscapes”, is organized into three sections. Each section was originally written as a separate report and represents a different task in the subproject focusing on landscape fire risks. Because they have a common focus, the three reports were combined into this larger report-in-progress. The first section is a literature review that examines interface landscapes as they relate to structural vulnerability during wildfires. Other characteristics that influence structural vulnerability, such as building materials and community layout, are also discussed. The second section is a year-1 progress report on the post-fire assessment study. The literature review in section one provided much of the information that was used in developing the research methodologies for this study. The third and final section defines the major vegetation communities of the southern United States. While this section is not directly related to the post-fire assessment study, it represents a key component of landowner risk assessment procedures (see Report 3), which are currently being developed. Results from the post-fire study will also be incorporated in the risk assessment procedures during year 2.

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1. The Relationship Between Interface Landscapes and Structural Vulnerability: A Literature Review

Introduction

Wildland fires are a natural component of ecosystems across much of North America. When residential and/or developed areas abut wildlands (commonly referred to as the wildland-urban interface), these historically common wildfires can threaten lives and property. The 1970's marked a shift in population trends in the United States, with rural areas demonstrating a higher percentage increase than urban areas for the first time since the industrial revolution (Davis 1990). The migration of people to rural, natural settings, often for aesthetic and lifestyle reasons, coincides with a steady expansion of urban/suburban areas into wildlands. Not only does this migration expose people to naturally occurring wildfires, it also influences the frequency in which wildfires occur. Today, the majority of interface wildfires are caused by people (Bailey 1991). Fire professionals refer to these and other related issues as the wildland-urban interface (WUI) fire problem (Davis and Marker 1987). A critical area of research for addressing this problem focuses on the factors that influence the vulnerability of individual homes and/or entire communities to wildfire. Characteristics of the structures, such as building materials and maintenance, and landscape patterns around structures influence structural vulnerability. Landscape patterns can be examined at different scales, but most past research has focused on landscaping around individual homes.

The objective of this review is to describe important landscape patterns that contribute to structural vulnerability during wildfires, focusing on individual landowners. The basic concepts of fire behavior are described, as they relate to the movement of fire through interface landscapes. The literature on structural survival during WUI fires is then extensively reviewed, focusing on landscaping. Structures serve as an important fuel component during some WUI fires; therefore, the role of building materials and construction is also discussed.

Fire Movement Through Interface Landscapes

Fuel, weather, and topography are the key factors controlling the movement and intensity of fire, or fire behavior (Rothermel 1983). The primary fuels during wildland fires are living and dead plants, and their structure and arrangement influence their effect on fire behavior. Fires require a continuous fuel bed for sustained movement. In forests, surface fuels include understory shrubs, herbaceous groundcover, and dead plant matter (e.g., fallen leaves, downed logs) and are usually the main fuel layer that carries a fire. Aerial fuels include tree crowns and vines that grow into them. Forests with significant separation between the surface fuels and the aerials fuels will generally not support a high intensity crown fire. However, forests with large shrubs or trees of intermediate height may have continuity of vertical fuels which function as a ladder, carrying the fire from the surface to the tree canopy. The size of vegetative fuels is also important, with the small, lightweight fuels (e.g., leaves, small diameter branches) igniting and burning quickly, and the heavy, large fuels (e.g., downed logs) igniting slower, and burning hotter and longer once ignited (Pyne et al. 1996).

Several computer programs exist for predicting fire behavior in wildland fuels (e.g., BehavePlus (Andrews and Bevins 2001), FARSITE (Finney 1996)). At the wildland-urban interface, wildland fires have the potential to spread into communities causing significant loss of property or even life. However, once a fire enters a community, fire behavior predictions become more complex as structures add an additional, unique fuel component (Chandler et al. 1983). Structures are discrete fuels that are larger than any vegetative fuel, and they differ significantly from wildland fuels in their effect on fire behavior, including fire spread (Rehm et al. 2002). Once ignited, structures function as large ignition sources that produce radiant heat and firebrands (Cohen 1995 and 2000b, NFPA a). A modeling system is being developed for the purpose of understanding and predicting community-scale fire spread (Rehm et al. 2002), but no such models are currently available for fire managers.

Factors Determining Structural Survival During WUI Fires

Past research has focused more on individual home ignitions than on community-scale fire spread. Most studies were based on field observations of houses that were threatened by wildfires, examining both houses that burned and those that survived. The nature of these observational studies, referred to as post-fire assessments, precludes conclusions on cause and effect. However, single factor and regression analyses of the results indicate which factors may be important in determining structural survival (Foote and Gilless 1996). The National Fire Protection Association (NFPA) conducted a series of fire investigations following several major WUI fires in the early 1990s in response to growing concerns about the wildland-urban interface fire problem (NFPA a, b, c, d). In addition, case studies have been conducted after WUI fires in California, Florida, and Australia (Foote and Gilless 1996, Abt et al. 1987, Wilson and Ferguson 1986).

Several factors have consistently been shown to influence structural survival in wildland-urban interface fires. Fire behavior, vegetation clearance, and building materials (especially roofing) appear to be the most important. When wildfires exhibit severe fire behavior, such as crowning and spotting, there is little that fire services can do to protect homes at the head of the fire (Roussopoulos and Johnson 1975). Only changes in the weather conditions or fuels can alter the fire's path. Wilson and Ferguson (1986) found that fire behavior was the single most important factor determining house survival;

therefore, their top recommendation for prevention of future conflagrations is fuel management/reduction. Other studies have also found a correlation between severe fire behavior (crowning) and structure loss (Abt et al. 1987, NFPA d).

Landscaping Around Homes

Another important factor in determining structural survival is vegetation clearance, which can directly influence the intensity of fire to which an individual house is exposed. Most past studies support the common recommendation that a minimum of 30 feet around structures be cleared of flammable vegetation (Howard et al. 1973; Wilson and Ferguson 1986; Abt et al. 1987; Foote and Gilless 1996; NFPA a, c, d). In addition to landscape plants, other 'fuels' around a house are often cited as potentially important to structure loss, such as nearby sheds or woodpiles (Wilson and Ferguson 1986, NFPA b, Cohen 2000a). While the arrangement of vegetation around homes is an important factor influencing structural survival, few studies have examined it in detail.

Quantifying the characteristics of landscape vegetation during post-fire data collection can be difficult and time consuming (Foote et al. 1991), and therefore, most post-fire observational studies simply use the clearance (distance from structure) of flammable vegetation to characterize the vegetation component (Wilson and Ferguson 1986, Abt et al. 1987, Foote and Gilless 1996, DeWitt 2000). Furthermore, vegetation is classified using broad groupings, such as grass, shrubs, or trees. While this basic information is important, it cannot be used to examine the structure and arrangement of the vegetation (e.g., comparisons between individual plants, landscape islands, and natural forest stands). The vertical and horizontal structure of vegetation can significantly influence its associated fire hazard (Gilmer 1996).

Another landscape component that could be useful but is rarely collected during post-fire research is information on species composition. Detailed data on species are often excluded because identification can be difficult when the plant being examined is severely charred. Furthermore, relating species information to fire hazard is difficult unless various fuel characteristics of individuals or groups of plants are known. To relate information on plant species to structural hazard, investigators must understand such characteristics as fuel loading, fuel moisture content, height, and continuity, and collecting these data is time consuming (Foote et al. 1991). During post-fire data collection for the Santa Barbara Paint Fire of 1990, researchers excluded non-hazardous vegetation when determining clearance distances, using knowledge of the flammability of the local flora (Foote et al. 1991). However, this technique would be difficult to implement in most locations, due to significant voids in species-specific flammability literature.

Many of the problems and difficulties that accompany observational studies on structural survival could be avoided when conducting controlled experiments. For example, fuel characteristics of plants can be recorded prior to fire ignition and heat released by the fire can be measured. However, the significant costs and space requirements for such experiments can be prohibitive. In one of the few controlled experiments to examine structure ignition as it relates to vegetative clearance, or defensible space, Cohen (2000b) found that radiant heat from a high intensity crown fire would not ignite wood surfaces (such as wood siding on a house) at distances greater than 40 meters. The experiment was conducted in a western United States forest system composed of jack pine with a black spruce understory. Considering data from the crown fire experiment, multiple case studies of wildland-urban interface fires, and a computer model that assesses structure ignition (SIAM (Cohen 1995)), Cohen (2000b) concludes that maintaining an area of 10 to 40 meters around a home with proper landscaping and building materials is the most effective strategy for protecting homes from WUI fires. More controlled experiments in a variety of ecosystems would further support this conclusion and allow for more specific landscaping guidelines at the regional or ecosystem level.

Building Materials/Maintenance

If a high intensity fire comes within a critical distance of structures, building construction materials and maintenance become important factors influencing survival (Cohen 2000b). While radiant heat or flames can directly ignite structures, floating embers (referred to as firebrands) are also a threat. Firebrands can ignite homes by settling on flammable roofs or decks, lighting fuels immediately adjacent to structures, or entering homes through ducts or vents (Foote and Gilless 1996, Cohen 2000b). In wildland fires, the roof is often the most vulnerable part of a home (NFPA c). Flammable roofing material such as wood shingles has been linked to structure loss in many past WUI fires (Wilson 1962, Howard et al. 1973, Wilson and Ferguson 1986, Graham 1988, NFPA a, NFPA c, Foote and Gilless 1996). Other characteristics of building construction that may influence structural survival include window size/type (Wilson and Ferguson 1986, Graham 1988, NFPA c, Ramsay et al. 1996,); exterior wall and building frame materials (Wilson and Ferguson 1986, Abt et al. 1987, Ramsay et al. 1996, DeWitt 2000); and flammable decks, balconies, or fences (Foote and Gilless 1996, DeWitt 2000). Finally, building maintenance can be important. Lofted embers may ignite debris in gutters or on the roof and increase the risk of structural ignition (Wilson and Ferguson 1986, Abt et al. 1987, DeWitt 2000, Cohen 2000a, Cohen 2000b).

Community Layout

Within a residential development, poorly planned road systems cause multiple problems for fire services. Points of ingress and egress of insufficient width for fire service vehicles can hinder suppression activities (NFPA a). In addition, fatalities have occurred during WUI fires when narrow roads prevent the simultaneous evacuation of residents and entry of fire services (NFPA c).

Research Needs

The survival or loss of homes during WUI fires is determined by multiple factors, including fire behavior, defensible space, structural properties, and community layout. Various documents have been developed for homeowners, developers, fire services, and politicians with information on protecting homes from wildfires. However, most guidelines contain no documentation of how they were developed and are often based on publications developed in other states or at the national level. While recent studies have attempted to validate current home protection strategies, more observational data on structural survival must be collected to test current guidelines (DeWitt 2000).

One example of a mitigation practice that may warrant modification is the common recommendation of 30 feet of defensible space. The factors that influence the effectiveness of defensible space, including fuel type, fuel loading, and topography, vary significantly geographically. In recognition of this variation, the state of California developed an ordinance, Public Resource Code 4291, which requires a minimum of 30 feet of defensible space around homes in high fire hazard areas, but the law allows local regulatory agencies to increase the required area up to 100 feet under certain conditions (e.g., steep slope). However, in Florida, as in many other states where wildfires frequently threaten homes, the recommended area of defensible space is 30 feet regardless of local conditions.

A second potential modification of current recommendations could focus on the arrangement of vegetation within the defensible space zone. An extreme example of a fire-safe 'yard' with excellent defensible space might contain no plants within 100 feet of the structure with either rocks or dirt as the only ground cover. Such a yard would have no fuels for an approaching fire; however, a multitude of other problems may develop. A yard with no vegetation would have a low value in terms of energy conservation (due to lack of shade), water conservation (high evaporation from lack of shade, erosion and runoff problems), and wildlife habitat (low quality food and cover for most wildlife). Small landowners often have multiple management objectives; therefore, recommendations for creating fire-safe landscapes should consider these other issues when possible. Rather than defining defensible space in terms of a 'vegetation clearance', a better management strategy might be to discuss arrangement of vegetation within the zone, focusing on minimum separation distances that prevent both vertical and horizontal continuity of fuels.

Future research should focus on developing a better understanding of how the arrangement and species composition of landscape plants influence structural vulnerability. During post-fire assessments, measuring vegetation clearance alone will not provide enough information; detailed descriptions of landscape design around structures and species identification are necessary. Examining current fire hazard mitigation recommendations under a variety of local conditions will help fire professionals identify potential improvements, such as the preceding examples, and supply policy makers with the empirical data required to develop and implement public policy focused on fire prevention.

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2. Post-Fire Assessment of Interface Landscapes: Year 1 Progress Report

Completed Tasks: May 2001 – September 2002

Abstract

One of the major issues in the southern wildland-urban interface is the loss of homes and structures to wildland fire. While fire control agencies play an important role in reducing fire hazards and protecting homes, individual landowners must also assume some responsibility for mitigating their risk. To do this, landowners need information on how to fireproof their home and surrounding landscape. A wide variety of recommendations currently exist for homeowners, but most were developed nationally, or in the western states. To develop recommendations that are specific to the southern United States, we must expand our understanding of how southern interface landscapes influence the survivability of homes during wildfires. The objectives of this study are to examine the relationship between southern landscape patterns and structural vulnerability, and to assess the utility of current national recommendations for maintaining fire-resistant homes in the south. We visited communities where multiple homes were threatened by wildfire, and collected data on landscape characteristics and building materials of homes that were damaged and those that were not.

Introduction

This three-year study, initiated in May 2001, examines characteristics of wildland-urban interface landscapes as they relate to structural vulnerability during wildfires. The research focuses geographically on the southern United States, but the majority of the data will be collected in Florida. The study relies on field observations of landscaping around homes in communities threatened by wildfires, and will include both houses that burned and those that survived. Because the study was designed to examine homes and landscapes after a fire has occurred, it is referred to as a post-fire assessment study. Within three weeks after a fire, each threatened home is visited and data are collected on multiple variables associated with structure loss during wildfires. A primary objective of the study is to improve our understanding of the relationship between interface landscape patterns and structural vulnerability. Therefore, detailed measurements of landscape plants, including their structure and arrangement, are made during the post-fire assessments. Other variables that are measured include building materials, building maintenance, and community design.

Additional information on fire weather and suppression activities is obtained from agency fire reports. Individual homeowners are also interviewed for information on any preventive or defensible actions that were taken and to better characterize the property prior to the wildfire event.

Protocol for Site Selection and Data Collection

Site selection and data collection follows a multiple step protocol. First, the state's cooperative fire protection manager forwards '209' reports for interface fire sites that meet the selected criteria via email to the research team. A 209 report summarizes the status of a single wildfire incident, and it includes information on the fire's size, percent containment, and threats to structures or other property. The second step involves a member of the research team visiting the site to further assess suitability for the study. Candidate sites are those where multiple homes were threatened and at least one home was damaged or destroyed by wildfire. For the purposes of this study, a home is considered threatened if wildfire ignites vegetation or other structures within 100 feet of the home. If the site is acceptable, the fire's incident commander and other appropriate individuals are interviewed and fire reports, maps, and other applicable information are reviewed. During the third step, one or more field crews visit the selected site. Upon gaining permission from the homeowner to inventory site conditions, the crews assess damage, map the vegetation around the homes (recording plant species and arrangement), record structural properties (roofing type, exterior siding, etc.), and interview the homeowners. The homeowner interviews solicit supplemental information on mitigation practices conducted prior to the fire, as well as suppression activities during the fire.

Major Tasks Completed During Year 1

Literature review / Research plan

A literature review was completed on the relationship between interface landscapes and structural vulnerability (attached to this report). The review was used to develop the research plan for the post-fire assessments. Specifically, a matrix was developed for comparing the different variables that were examined during previous post-fire studies, and all variables that significantly influenced structural survival were included in the current study.

IRB protocol

Because our methodology includes personal interviews and a formal consent process from human participants (landowners), we had to develop a protocol for review by the Institutional Review Board (IRB). The IRB protocol outlines the procedures for contacting landowners and gaining consent to participate in the study. It also presents the specific format for the landowner interviews. The University of Florida Institutional Review Board approved the protocol in March 2002.

Field tested post-fire methodology

During the months of January through April, the methodology for the post-fire assessments was field tested and refined. A final practice run was conducted on April 9, 2002, and all field crew members were trained to ensure accurate and consistent sampling techniques.

Year 1 data collected

During the first year, post-fire assessments were conducted at two sites. Both fires occurred during May 2002. The first site was in Highlands County, Florida, in a subdivision near the town of Sebring that is surrounded by upland pine scrub habitat. The wildland vegetation consisted of sparsely distributed pine trees (*Pinus clausa*, *Pinus elliottii*) with a dense shrub layer that included saw palmetto, sand live oaks, water oak, and other understory woody and herbaceous species. Three houses were threatened, but only one was damaged. The second study site was in Bonita Springs, located in Lee County, Florida, and only one of the threatened homes was damaged. The dominant wildland vegetation surrounding homes in the Bonita Springs subdivision was a dense forest of slash pine and melaleuca (*Pinus elliottii*, *Melaleuca quinquenervia*). Shrub species that were present included Brazilian pepper (*Schinus terebinthifolius*) and saw palmetto (*Serenoa repens*). Year 1 data were not analyzed statistically; however, several preliminary observations were noted.

Preliminary Results

Observations – Year 1 data

- During both fires, the damage to structures occurred when vinyl interior window blinds melted from radiant heat (transmitted through single-pane windows).
- In both cases, the windows where the damage occurred were less than ~9 m (30 ft) from burning wildland vegetation.
- At one of the damaged homes, metal screening covered half of the window where the damage occurred. The screening apparently reduced the amount of radiant heat transmitted through the window significantly, as the interior blinds were only melted on the half of the window that lacked screening (Figure 1).

- Firebrands ignited pine straw mulch in a landscaped island immediately adjacent to one house. However, the homeowner, who was onsite during the fire, discovered the burning mulch and extinguished it before any damage to the structure occurred.

Figure 1. Damage to the vinyl interior blinds during a wildfire in Bonita Springs, Florida. Note that the fire only melted the blinds on the unscreened half of the window.

3. Defining Vegetation Communities in the Southern Interface

Introduction

Fuel hazards are a function of the predominant vegetation community and species as well as the density, size and distribution/continuity of individual plants within the landscape. Thus, a fuel hazard assessment for southern interface landscapes must focus on two key components: inherent fire behavior (rate of spread and intensity/heat load) in major ecosystems, and changes in those fire parameters with modifications of the landscape vegetation.

This report-in-progress describes the major vegetation communities that encompass most southern WUI landscapes and the typical fire behavior that occurs in each. The report entitled "Landowner Risk Assessment in the Southern Wildland-Urban Interface" describes the process that is underway to utilize fire behavior models to determine specific fire behavior in each ecosystem under severe fire weather conditions and with changes in fuel loads. Risk ratings derived from the model outputs will represent one dimension of the fuel hazard matrix: fire behavior in the general vegetation communities encompassing WUI residences.

Within the general landscape, however, the second dimension of the fuel hazard matrix involves adjustments for landscaping differences around individual homes (such as large open yards vs small narrow cleared areas; or scattered large trees with high crowns vs large trees with ladder fuels). The original intent of this project was to derive information for making those adjustments from fire reports of past fires, but that resource is more limited than originally anticipated. Therefore, during year 2 of the project, risk ratings for the landscape matrix (composed of general vegetation communities and landscape modifications) will be developed using a combination of fire behavior modeling and extensive review and input from fire agencies around the South. The process for completing the matrix rating is described at the end of this report.

Vegetation Ecosystems and Fire

The southern United States covers an area of 13 states from Florida in the far southeast, north to Virginia and west to Texas. Over this large area, climate, topography, and soils vary significantly, as do other natural forces, such as wildland fire. These environmental conditions influence the species composition of plants and animals, resulting in a great diversity of ecosystems. Most southern ecosystems have a history of wildland fire activity, although the relative frequency and intensity of fires in the different ecosystems varies. This paper will describe the dominant southern plant communities in the context of their fire behavior and then outline procedures for homeowners to assess their wildfire hazard considering the surrounding plant communities. Wetland plant communities, such as cypress swamps and mangroves, will not be covered since they are not areas of significant interface development. We first divide the southern United States into three physiographic regions: the Coastal Plains, Piedmont, and highlands.

Physiographic Regions

Coastal Plains

The physiographic region defined as the Coastal Plains includes the Gulf Coastal Plain, the Atlantic Coastal Plain, the Florida peninsula, and the Mississippi River alluvial plain (based on Braun 1950, Komarek 1974, Walker and Oswald 2000). Considering the variation in soils and topography across the region, a distinction is commonly made between the Upper and Lower Coastal Plain. The Lower Coastal Plain is characterized by low relief and younger terraces, where the water table is often very close to the soil surface (Christensen 1981). The Upper Coastal Plain contains older terraces where erosion has exposed older sediments and created greater relief, similar to the Piedmont region. In terms of past and present fire activity, the most important cover type in the Coastal Plain is the southern pine forest (Komarek 1974, Christensen 1981, Wright and Bailey 1982). Other important cover types include shrublands, bottomland or swamp hardwoods, and oak-pine scrub. Mixed oak-pine forests are also common in the region.

Piedmont

The Piedmont represents the region between the Coastal Plain and the highlands of the Appalachian Mountains, and it also includes the interior plateaus. The topography of the region is characterized by rolling hills with highly weathered soils, often with high clay content (Christensen 1981). Major cover types in the Piedmont include mixed pine-hardwood forests, hardwood forests dominated by oak and hickory, and old fields (Christensen 1981). Pure and mixed stands of loblolly and shortleaf pine are also common.

Highlands

The highlands of the southern states include the southern Appalachian Mountains and the Ozark and Ouachita Mountains of Arkansas and Missouri. Shallow, poorly developed soils characterize the region. Eastern deciduous oak-hickory forests are the most abundant cover type in the highlands, but coniferous forests occur in areas of recent disturbance and at higher elevations (Christensen 1981).

Dominant Plant Communities

Pine Forests

Forests dominated by conifers are a major forest cover type in the southern United States, and they occupy sites in all three major physiographic regions. In the Coastal Plains, **pine forests** predominate with the most common species being slash, loblolly, and longleaf pines. However, shortleaf, sand, and pond pine are also important in some regions. The structure and species composition of the understory of Coastal Plain pine forests are determined primarily by hydrology and disturbance regimes, but they usually contain a mixture of herbaceous plants and shrubs. For example, the xeric sandhill pine forests have an open canopy of longleaf pine with herbaceous ground cover dominated by grasses. However, moist flatwoods sites often have a higher density of slash pine trees and significant shrub cover in the understory, including such species as gallberry, saw palmetto, and wax myrtle (Christensen 1981, Walker and Oswald 2000). The height and density of the shrub layer in flatwoods sites is highly dependent on fire frequency, and in the absence of fire, the sites may develop into southern mixed hardwoods (Monk 1968).

Coniferous forests in the Piedmont include a variety of species found in both the highlands and Coastal Plains, but the most common species are loblolly and shortleaf pine, which have been planted over large areas of Piedmont forests (Walker and Oswald 2000). Finally, the highlands contain patches of coniferous forests sparsely distributed among the large expanse of eastern deciduous forests. Table-mountain and pitch pine occur in areas of high elevation or on ridge tops. Pure stands of red spruce and fraser fir occur at the highest elevations of the southern Appalachians, and old fields are often invaded by even-aged stands of eastern white pine (Walker and Oswald 2000).

Shrublands

Shrub-dominated communities of the Coastal Plain characteristically have longer fire return intervals than most southern pine forests, but when fires occur, they are often intense. **Scrub** is a shrub community that occurs along the relict shorelines of peninsular Florida on deep sandy soils. The dominant plant species include a variety of evergreens such as sand live oak, saw palmetto, and rosemary (Christensen 1981, Myers 1990). An open overstory of pines may or may not be present, composed of sand and/or longleaf pine (Myers 1990). The low nutrient conditions of the sandy soils result in a slow rate of fuel accumulation (Christensen 1981), and consequently, a significantly longer fire return interval than most southern pine forests. Under many conditions, lightning ignitions result in low intensity fires that burn only a short distance in the sparse groundcover. However, after several decades of scrub development, hot dry windy conditions can result in intense fires that burn virtually all aboveground material (Christensen 1981).

Flatwoods shrub communities of gallberry, saw palmetto, wax myrtle, fetterbush, yaupon holly, titi, and a number of less common species often occur as understories in natural pine stands and plantations. However, they also develop over extensive open areas and after logging. Within 4 to 5 years after a disturbance these plant communities represent one of the most volatile and dangerous ecosystems for fire in the Southeast. In hot, dry spring weather long flame lengths, rapid rates of spread and long-distance spotting make fire control very difficult, especially when the shrubs are in the open with no overstory to reduce wind speed.

Pocosins are similar shrub communities that dominate poorly drained interstream terraces in the Upper Coastal Plain, primarily in the Carolinas (Christensen 1981). Like scrub, pocosin communities are characterized by low productivity soils. Intense fires occur during drought periods when the normally moist soils dry out (Christensen 1981).

Upland Hardwood Forests

Hardwood forests occur over a range of hydrologic conditions. In the Lower Coastal Plain, **mixed hardwood forests,** composed of a mixture of deciduous and evergreen hardwoods, and often some pines, are common in floodplains or intermediate zones between wetland areas and uplands (Christensen 1981, Platt and Schwartz 1990). Most hardwood species are vulnerable to fire during early development, and therefore, require extended periods of time without fire to reach dominance in the forest canopy. However, once mature, these hardwood forests generally have an open understory with scattered to moderate shrub and herb development and do not support large, high intensity fires. In hammocks, where leaf litter may be the main ground cover, fire intensity is usually very low (Platt and Schwartz 1990).

In the Upper Coastal Plain, **mixed deciduous forests**, composed of oaks, hickories, sweetgum, magnolia and a number of less common species, occur in areas of low fire frequency, and they are often considered to be “climax” communities (Cain and Shelton 1994, Wade et al. 2000). In hardwood forests, wildfires are generally infrequent and small in size, when they occur (Christensen 1981, Wade et al. 2000).

In the Piedmont and highland regions, the highly diverse **eastern deciduous forests** are the most common forest cover type, and most can be classified as oak-hickory forests (Komarek 1974, Christensen 1981, Walker and Oswald 2000). Based on historical records and observations, the eastern deciduous forests of the Piedmont and lower regions of the highlands were more open and possibly even savanna-like during presettlement times (Christensen 1981). Frequent fires from lightning and Native American ignitions were important in maintaining the open forest structure. Today’s eastern deciduous forests are dense and often contain a substantial understory of young trees and shrubs due to extended periods without disturbance. Therefore, when fires do occur, they tend to be more intense and destructive than they were historically (Christensen 1981). In the highlands, the **mixed mesophytic forests** (dominated by deciduous hardwoods, including maples, beech, black cherry and basswood) are some of the most diverse forests in the world. Infrequent disturbance is thought to contribute to their diversity, with major disturbance events occurring once every 200 to 400 years (Christensen 1981).

Bottomland Forests

Bottomland forests vary significantly in their structure and species composition across the Coastal Plain and Piedmont; the primary factors controlling this variation are hydrology, site productivity, and disturbance frequency. The alluvial plains associated with the Mississippi River support large expanses of bottomland forests. The dominant tree species are often a mixture of deciduous and evergreen species including cypress, Atlantic white cedar, various bays, tupelo, oaks, ash, magnolia, and red maple (Christensen 1981, Ewel 1990, Walker and Oswald 2000). Fire frequency in bottomland forests ranges from 5 to 200 years, but is generally infrequent and low intensity (Ewel 1990). Inundation is an important form of disturbance that influences the understory composition of bottomland forests. In general, the wetter, more permanently flooded sites have open understories with few shrubs or terrestrial herbaceous plants. Wetlands that flood only seasonally or biennially may contain a more dense groundcover and substantial shrub layer. Periodic fire may be necessary to maintain certain bottomland communities; for example, fire in cypress wetlands may prevent them from succeeding to mixed hardwood communities (Ewel 1995).

Grasslands

A variety of cover types fall into the category of grasslands, including marshes, prairies, savannas, and old fields. Hydrology and disturbance are important for the maintenance or development of these cover types. Shrub or tree species are often present, and in some communities, such as the old fields of the Piedmont and highlands, succession to tree-dominated communities can occur if fire is suppressed. However, fire is necessary to maintain the pine savanna communities of the Lower Coastal Plain. Depending on the tree density at a given site, pine savannas can be considered as grassland communities or forest communities. Fire behavior in grasslands is highly variable. Fire spread rates are generally higher than in any other plant community when grasses are cured or have low live fuel moisture contents. However, flame lengths and intensity may vary from very high in sawgrass and cogongrass to lower intensities in other ecosystems.

Agricultural lands

Agricultural lands cover large expanses of land across the Coastal Plains and Piedmont. They represent a variety of agricultural uses, including pastures and croplands. Agricultural lands are structurally similar to some grassland communities; however, irrigation and tillage generally result in low fire intensity and spread rates.

Rating System Adjustments for Landscaping Modifications

A summary of the ecosystem hazard ratings, along with a draft of the landowner risk assessment guidelines (see accompanying report "Landowner Risk Assessment in the Southern Interface"), will be distributed to fire control and management agencies in all the southern states for review and comment during the second year of the project. Included with our ecosystem hazard ratings will be suggestions about modifying those ratings for different landscape patterns around homes and a survey form through which respondents can suggest appropriate adjustments based on their experience. Landscape modifications will include: size of green lawn; size and distribution of tree/shrub islands; vertical structure of adjacent trees and shrubs in landscaped zone; distance to wildland fuels (defensible space); general types of ground cover; and landscaping 'zones' surrounding homes. Analysis of the compiled responses will be used to prepare a second draft of the landscape matrix risk rating system.

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